Is There Downward Nominal Wage Rigidity in the Canadian Phillips Curve?

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ABSTRACT

This paper examines the evidence for downward nominal wage rigidity in provincial wage Phillips curves over the period 1981–1999. Three Phillips curve models are used: a standard model; a model with hysteresis; and a model in which downward nominal wage rigidity is explicitly modelled. In each model the paper finds that there is significant evidence of downward nominal wage rigidity over the period studied. Simulations of the downward nominal wage rigidity Phillips curve indicate that reducing inflation by one percentage point from its 1999 level would lead to an increase in the unemployment rate of about one percentage point.

I. Introduction

What is the socially optimal level of inflation? While there is often a presumption that lower inflation is necessarily better, moving to a lower inflation rate can generate costs in terms of higher unemployment that outweigh the possible gains. Two types of costs are usually considered:

1. Costs of Disinflation

These arise because of persistence, or hysteresis, in the unemployment rate, which slows the adjustment to a new equilibrium. In a recent paper, Ball (1999) finds considerable evidence for the importance of this kind of mechanism in explaining the recent behaviour of unemployment in many OECD countries. Typically the costs implied by hysteresis are not permanent; however in extreme cases it may that the unemployment rate never returns to its long-run natural rate after a shock.

2. Costs of Low Inflation

In addition to the costs of getting to a lower inflation rate, one must also consider the costs of maintaining inflation at a lower level. In a controversial paper, Akerlof, Dickens and Perry (ADP) (1996) argued that very low inflation rates could lead to permanently higher unemployment if there is downward nominal wage rigidity, which makes wage cuts harder for firms to implement when inflation is low.

The existence and magnitude of both kinds of costs of moving to lower inflation depend crucially on the shape of the Phillips Curve.[2] In this paper we examine the evidence on the nature of the Phillips curve and the unemployment–inflation trade-off in Canada. We begin with a review of the debate in Canada over the existence and implications of downward nominal wage rigidity. We then outline three different models of the Phillips curve: a standard expectations-augmented Phillips curve; a Phillips curve modified to allow for persistence or hysteresis; and Phillips curve that explicitly allows for downward nominal wage rigidity. We estimate these models using wage data disaggregated by province. A particular feature of our analysis is that we pay close attention to the correct modelling of factors such as changes in social programs that may have played an important role in changing the long-run natural rate in Canada in recent years. We then simulate the costs of moving to lower inflation using our preferred model.

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[2] For a discussion of the benefits of low inflation see Ragan (1998).

II. The Debate Thus Far

Since the seminal paper on downward nominal wage rigidity by Akerlof, Dickens and Perry (1996), there has been a lively debate about the existence and implications of downward nominal wage rigidity. This debate has been particularly animated in Canada: in his 1996 Presidential Address to the Canadian Economics Association, Pierre Fortin argued that the severity of the recession in Canada in the 1990s relative to the United States was a result of the significantly lower inflation in Canada. This argument drew a forthright rebuttal from Freedman and Macklem (1998).

This debate on downward nominal wage rigidity and the Canadian Phillips curve has essentially revolved around two questions. First, do micro data support the existence of downward nominal wage rigidity at the level of individual firms and workers? Second, what is the evidence that downward nominal wage rigidity, even if it exists, has a significant impact on aggregate labour market outcomes in Canada?

1. Evidence of Downward Nominal Wage Rigidity from Microdata

Both Fortin (1996), and Friedman and Macklem (1998), have relied heavily on evidence from wage contract data to support or refute the hypothesis of downward nominal wage rigidity. These data, which come from large unionized firms in both the public and private sector, are useful because they provide data on actual wage rates, rather than measures such as weekly earnings which may vary with changes in hours. In subsequent analyses of these data, Simpson, Cameron and Hum (1998) found significant evidence of downward nominal wage rigidity. Faruqui (2000) looked for evidence that downward nominal wage rigidity had an impact on employment growth in Canada over the 1990s, and found little or nothing.

Useful though the wage contracts data are, they have a serious flaw: most Canadian workers do not work for large unionized firms. One approach to gaining a broader perspective on the wage formation process would be to use survey data that covered all those employed in the labour market. Although little work of this kind has been done in Canada, there has been work done elsewhere using microdata. Using data form the U.S. Panel Study of Income Dynamics, McLaughlin (1994) found that nominal wage cuts were quite frequent. (This conclusion was supported using British data by Smith (2000)). However, McLaughlin's results were criticized by Akerlof, Dickens and Perry (1996), who argued many of the nominal wage cuts that appear in the PSID are actually a result of measurement error. This conclusion was supported by a study by Altonji and Devereux (1999), who found considerable evidence of downward nominal wage rigidity, once measurement error is allowed for.

2. *Evidence of Downward Nominal Wage Rigidity from Macrodata*

In their original paper, Akerlof, Dickens and Perry (1996) estimated a Phillips curve incorporating downward nominal wage rigidity on aggregate U.S. data. One drawback to their methodology was that in order to find a period of very low inflation in which to test the downward nominal wage rigidity hypothesis in the U.S. one has to go back to the 1930s. In Canada, however, the 1990s provide a much more recent period of very low inflation with which to test the hypothesis. Djoudad and Sargent (1997) applied Akerlof, Dickens and Perry's method of estimating a Phillips curve that allows for downward nominal wage rigidity to aggregate Canadian data and found empirical support for the hypothesis. However, the complicated econometric methodology used by Akerlof, Dickens and Perry (1996) and Djoudad and Sargent (1997) was criticised by Hogan and Pichette (2000). Fortin and Dumont (2000) have proposed a simpler methodology for incorporating downward nominal wage rigidity, with some empirical success.

In the study closest to ours, Farès and Lemieux (2000) use provincial level data taken from the Survey of Consumer Finances to estimate a Phillips curve for Canada over the period 1981 to 1997. They estimate a short-run Phillips curve of the form

$$\dot{w}_{it} = \alpha_i + \gamma_t + \beta_i \cdot u_{it} + \varepsilon_{it}, \qquad (1)$$

where w_{it} is real wages and u_{it} is unemployment in province i in year t. They test for downward nominal wage rigidity by allowing the slope of the Phillips curve β_i to take a different value in the low inflation period beginning in 1992. A lower value of the slope coefficient in this period would be consistent with downward nominal wage rigidity because it would indicate that the inflation–unemployment tradeoff had become worse under conditions of lower inflation.[3] The authors find that while there is some evidence of a fall in the slope of the Phillips curve in the estimates of their aggregate model, and upon an initial inspection of the provincial data, the estimation results from their provincial level model indicate no change in the slope of the Phillips curve after 1992.

One weakness with the Farès and Lemieux study is that they do not attempt to model explicitly changes in provincial Phillips curve that might be caused by changes in productivity or by factors such as social program disincentives or minimum wages. Instead, they rely on the aggregate trend variable γ_t to pick up these variations. Missing provincial variations in the change in these factors over time will tend to cause measurement error in the Phillips curve relationship and so bias the estimates of the slope of the Phillips curve.

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[3] However, it must be borne in mind that this formulation is a very rough approximation to downward nominal wage rigidity. As we shall discuss subsequently, we argue that the estimation of an explicit model of *nominal* wage change is a preferred strategy when investigating downward nominal wage rigidity.

Farès and Lemieux attempt to reconcile their results with the substantial micro evidence in favour of downward nominal wage rigidity by arguing that downward nominal wage rigidity is likely only binding for more senior workers, whose real wages seem to be relatively inflexible over the business cycle, and that there is little change in the wages of these workers after 1991. Although the real wages of workers with less than one year of tenure fell considerably in the 1981–1982 recession, but hardly at all in the 1990s, Farès and Lemieux argue that these workers are unlikely to be affected by downward nominal wage rigidity.

There appear to be two potential objections to this line of reasoning. Firstly, Farès and Lemieux's data (Figure 8 on p.37) actually seem to indicate considerable cyclicality in the real wages of workers with between 1 and 10 years of seniority, as well as for workers with less than one year seniority, and for these more senior workers the drop in real wages in the 1981–1982 recession is much more significant than in the 1990–1992 recession and its aftermath.

Secondly, downward nominal wage rigidity could well apply to the real wages of newly hired employees. For example, if these employees are performing similar work to employees of longer job tenure, and if it is difficult for firms (perhaps because of unions or legal constraints) to pay people of different tenures different wages for the same job, then firms will not be able to offer lower wages to new hires. Furthermore, legal minimum wages are definitely subject to downward nominal wage rigidity, and young people, who have little job tenure virtually by definition, tend to be disproportionately employed in minimum wage jobs. Finally, downward nominal wage rigidity may well extend not only to wages in current jobs, but also to the reservation wages of those searching for jobs. If this is so, firms will be more reluctant to reduce wages for vacant positions in periods of low inflation because they will have fewer applicants for these positions, making them more costly to fill.

III. Conceptual Overview

In this section we will outline three different formulations of the Phillips curve. The first is the basic textbook expectation-augmented Phillips curve. The second is the basic Phillips curve altered to allow for persistence or hysteresis, so that unemployment only returns slowly to its long run 'natural' rate. The third formulation is the basic Phillips curve modified to allow for downward nominal wage rigidity. Note that all three Phillips curves are specified as wage Phillips curves, rather than price Phillips curves, because our primary interest is rigidities in wages, not prices.

1. Basic Phillips Curve

The standard expectations-augmented Phillips curve can be expressed as

$$\dot{W} = \dot{P}^e + \dot{G}^e - b \cdot (u - u^*), \qquad b > 0, \tag{2}$$

where W is nominal wages, P^e is the expected price level for the period over which wages are set, G^e is the expected level of productivity, u is the unemployment rate, and u^* is the long run equilibrium unemployment, often referred to as the 'natural' rate. A dot over a variable (e.g. $\dot{X}$) indicates the log difference of that variable ($\ln(X) - \ln(X_{-1})$). The natural rate u^* includes real variables such as the generosity of social programs and demographic factors that might affect unemployment rates.

In order to solve for the long-run equilibrium one requires an expression for prices. We will simply assume that prices are a mark-up on unit labour costs, so that

$$\dot{P} = \dot{W} - \dot{G}. \tag{3}$$

A long-run equilibrium occurs when expected and actual prices and productivity coincide. It is easy to verify that in this case we must have $u = u^*$. How quickly this long-run equilibrium is attained depends on the expectations-formation process and the frequency with which nominal wages can be adjusted.

2. Phillips Curve with Hysteresis

The basic Phillips curve formulation (2), although it has its defenders, has not been very successful in explaining why unemployment fell so slowly in Canada after the recessions in the early 1980s and early 1990s, despite the relative stability of inflation rates. According to the basic Phillips curve model, there must have been a rise and subsequent

fall in the natural rate.[4] This seems somewhat implausible, given the lack of major increases in social programme generosity or of other changes that might motivate such a time path for the natural rate.[5]

Thus some commentators have argued that the basic Phillips curve model should be altered to allow explicitly for persistence in the relationship between wages and unemployment that does not arise from lags in wage-setting or in the formation of expectations. Possible microfoundations for such a specification are discussed at length in Jones (1995); examples include loss of skills or motivation of the long-term unemployed or greater insider wage setting power when unemployment is falling.

The Phillips curve modified to allow for persistence takes the form

$$\dot{W} = \dot{P}^e + \dot{G}^e - b \cdot \left((1-h) \cdot \left(u - u^*\right) + h \cdot \Delta u\right) \qquad (4)$$

where $h \in [0,1]$ is a parameter governing the degree of persistence. h=0 gives the basic Phillips curve model (2). When h=1, there is full hysteresis in the unemployment rate, so that only *changes* in the unemployment rate affect the rate of wage inflation. If h<1, then the model still has the natural rate property, so that there is ultimately only one long run equilibrium value for unemployment, u^*, which is determined only by real forces. However, the speed of adjustment will be slower than in (2), depending on how close h is to unity.

3. Phillips Curve with Downward Nominal Wage Rigidity

An alternative explanation for the behaviour of unemployment and inflation through the 1990s is downward nominal wage rigidity. In the downward nominal wage rigidity model, low rates of inflation impede the ability of some firms to cut real wages, and so unemployment is higher than it would otherwise be. The Phillips curve therefore becomes

$$\dot{W} = \Psi_\sigma\left(\dot{P}^e + \dot{G}^e - b(u - u^*)\right) \qquad (5)$$

where $\Psi_\sigma(x) = \sigma \cdot (x/\sigma \cdot \Phi(x/\sigma) + \phi(x/\sigma))$ and φ and Φ are, respectively, the p.d.f. and c.d.f. of the normal distribution.[6]

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[4] The other logical possibility is that price expectations and wages take a long time to adjust. However, not only would the speed of adjustment have to be implausibly slow for this explanation to work, one would also have to explain why inflation fell quite quickly when unemployment rose.

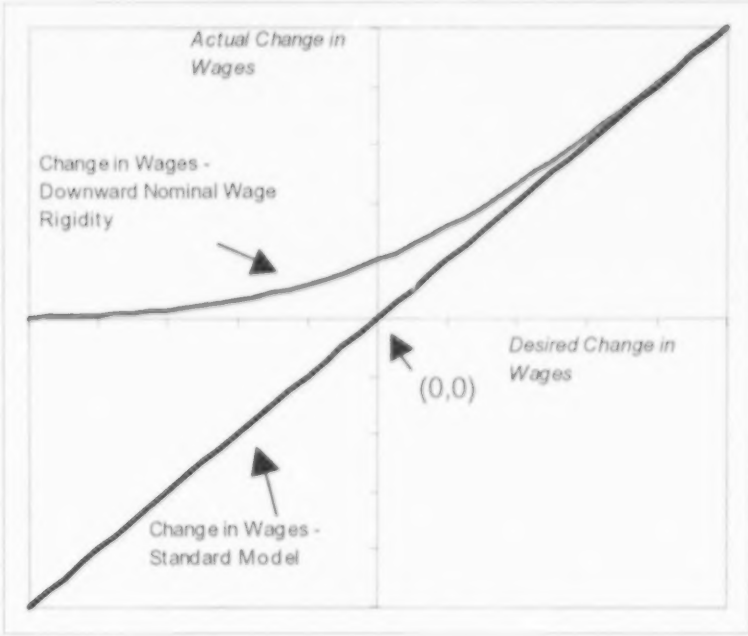
[5] See Sargent (2000) for evidence that technological change was not a major contributor to higher unemployment over the 1990s.

[6] This derivation is based on Fortin and Dumont (2000).

The function $\Psi_\sigma(x)$ is actually quite simple conceptually. When x is large (desired nominal wage change is large), then $\Psi_\sigma(x)=x$, and the basic Phillips curve relation holds. However, when x is very small, on average, then $\Psi_\sigma(x)\rightarrow 0$, and nominal wages do not fall, no matter how negative is x. The parameter σ reflects the degree of dispersion in desired wage change and thus, controls the smoothness of the transition between the basic Phillips curve regime and the binding downward nominal wage rigidity constraint regime. As $\sigma \rightarrow 0$ the transition becomes more abrupt since all firms desire similar changes in wages. Alternatively, as σ becomes large there is increased dispersion in desired wage change, so even if average desired wage change is positive, many firms are bound by the constraint. The slope of $\Psi_\sigma(x)$ is $-b\cdot\Phi$.

The function $\Psi_\sigma(x)$ is illustrated in Figure 1, which shows the relationship between desired wage changes and the actual wage changes. In the standard model, the two are the same. However, with downward nominal wage rigidity, firms are prevented from cutting nominal wages, so that if inflation and productivity growth expectations are low, some firms will be prevented from cutting wages, and so the actual average wage change will be above what it would be if there were no such restriction. When inflation or productivity growth are expected to be high, on the other hand, few firms wish to cut nominal wages, and wage growth is similar in both models.

Figure 1: Change in Wages: Standard Model vs. Downward Nominal Wage Rigidity Model


Actual Change in Wages
Change in Wages - Downward Nominal Wage Rigidity
Desired Change in Wages
(0,0)
Change in Wages - Standard Model

The long run Phillips curve generated by (5), along with the price equation (3), is not vertical, unlike the previous two specifications (for $h<1$). Instead it depends upon the level of desired wage changes. If inflation is low, there will be a permanent trade-off between inflation and unemployment because somewhat higher inflation will make it easier for some firms to cut real wages, so increasing employment.

IV. Estimation Results

In this section we shall confront the three different Phillips Curve models with the data. These models are shown in Table 1. In each case we shall test for whether there is evidence of downward nominal wage rigidity in the Phillips curve specification.

Table 1: Summary of Different Phillips Curve Specifications

	Short-run Phillips curve	Slope of SR Phillips curve	Slope of LR Phillips curve
Standard Model	$\dot{W} = \dot{P}^e + \dot{G}^e - b \cdot (u - u^*)$	$-b$	$-\infty$
Hysteresis	$\dot{W} = \dot{P}^e + \dot{G}^e - b \cdot \left((1-h) \cdot (u - u^*) + h \cdot \Delta u\right)$	$-b(1-h)$	$-\infty$ for $h<1$
Downward Nominal Wage Rigidity	$\dot{W} = \Psi_a \left(\dot{P}^e + \dot{G}^e - b(u - u^*)\right)$	$-b\Phi$	$-b \cdot \Phi / (1-\Phi)$

1. Description of the Data

The wage data that we use are taken from Statistics Canada's Survey of Employment, Payrolls and Hours. These data are compiled monthly from the administrative records of firms employing 20 persons or more in all sectors of the economy excluding agriculture. These data have a number of advantages for our purposes. Firstly, the data are for employees, and so exclude the self employed who are not subject to downward nominal wage rigidity. Secondly, the data are administrative, and therefore are not plagued by measurement problems, such as recall bias, that affect survey data. Thirdly, because the data are drawn from a large number of firms, there are no concerns about the sample size used to construct data for some of the smaller provinces.[7]

Expectations variables are formulated as follows. The expected rate of inflation is defined as the actual rate lagged one period. The expected rate of productivity growth is the Hodrick-Prescott filtered growth rate, with a smoothing parameter set to the conventional level of 100. [8] Further details regarding the construction of variables used in the analysis are given in the appendix.

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[7] The SEPH data are limited in that they do not reflect variation in aggregate wages resulting from variation in hours worked or the composition of the workforce.

[8] Our results may be sensitive to how expectations are modelled, but data limitations seriously curtail the scope for meaningful sensitivity analysis.

2. *Basic Model*

The empirical model corresponding to the standard model is based on the following specification:

$$\dot{W}_{it} = \dot{P}^{e}_{it} + \dot{G}_{it} - b \cdot \left(u_{it} - u^{n}_{it}\right) + e_{it} \qquad (6)$$

where *i* indexes province and where the provincial natural rates are given by

$$u^{n}_{it} = a_1 \cdot EI_{it} + a_2 \cdot SA_{it} + a_3 \cdot MW_{it} + c^{i} \cdot PROV_{i}\,. \qquad (7)$$

In equation (12) *EI* is the index of employment insurance disincentives, *SA* is the index of social assistance disincentives, *MW* is a measure of the relative minimum wage and *PROV* are dummy variables indicating province. Following Farès and Lemieux (2000), however, we allow for the possibility that the Phillips curve has shifted in the low inflation period of the 1990s. We follow them in estimating a modified form of (6):

$$\dot{W}_{it} = \dot{P}^{e}_{it} + \dot{G}_{it} - \left(b_1 + b_2 \cdot YRGT91\right) \cdot \left(u_{it} - u^{n}_{it}\right) + b_3 \cdot YRGT91 + e_{it} \qquad (8)$$

where *YRGT*91 is a dummy variable for the low inflation period that began after 1991. A negative value for b_2 would indicate that the slope of the Phillips curve had shifted down after 1991, which would be consistent with downward nominal wage rigidity making the trade-off between unemployment and wage inflation more severe.

Equation (8) was estimated using provincial data from all ten provinces over the period 1981–1999.[9,10] The estimation technique was seemingly-unrelated regression estimator, which allows for cross-equation correlation in the idiosyncratic shocks affecting each province. The results are shown in Table 2 below.

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[9] The sample period is chosen so that the starting date corresponds to Farès and Lemieux (2000).

[10] The specifications reported in this paper do not include the social assistance disincentives index. This index is at present available for only the four largest provinces. In an earlier version of this paper, the model with the index included was estimated using data from these four provinces over the same period. However, the coefficient for the index was not statistically significant.

Table 2: Results from the Basic Phillips Curve and Hysteresis Models

	Basic		Hysteresis			
	(1)		(2)		(3)	
	estimate	*std err*	*estimate*	*std err*	*estimate*	*std err*
b_1	0.64	(0.07)	0.69	(0.08)	0.71	(0.07)
b_2	-0.28	(0.08)	-0.38	(0.08)	-0.35	(0.08)
b_3	-0.07	(0.27)	-1.01	(0.32)	-0.67	(0.19)
h			0.54	(0.17)	0.37	(0.08)
EI	0.022	(0.007)	-0.035	(0.045)		
MW	0.24	(0.066)	0.60	(0.29)	0.40	(0.12)
NF	1.53	(3.16)	0.34	(7.90)	0.22	(4.81)
PE	-4.47	(3.52)	-8.63	(8.99)	-7.06	(5.60)
NS	-4.04	(3.10)	-8.37	(8.11)	-6.65	(5.01)
NB	-4.00	(3.16)	-7.87	(8.21)	-6.44	(5.08)
QC	-5.67	(3.19)	-11.21	(8.60)	-8.80	(5.25)
ON	-7.25	(2.87)	-14.17	(8.28)	-10.83	(4.85)
MB	-8.49	(3.12)	-16.16	(9.13)	-12.44	(5.31)
SK	-11.18	(3.30)	-21.23	(10.43)	-16.13	(5.74)
AB	-6.48	(2.72)	-11.50	(7.44)	-9.23	(4.51)
BC	-4.56	(2.87)	-7.96	(7.41)	-6.73	(4.59)
Det. Res. Cov.	2.78E-14		3.80E-14		3.17E-14	

Notes: Sample period is 1981–1999. Dependent variable is log change in wages less expected inflation and expected productivity growth. The estimation method was SUR. See the Data Appendix for variable definitions. The estimates reported for EI, MW and the province dummy variables correspond to a_1, a_3 and c' in equation (12) respectively.

In specification (1) the EI disincentives index and the relative minimum wage variable are significant at the 1 per cent level, and are predicted to increase the natural rate, as standard theory would suggest. The slope of the Phillips curve (b_1) is also significant and greater than zero, as one would expect. Importantly for the topic of this paper, the coefficient for the change in the slope of the Phillips curve after 1991 (b_2) is negative and statistically significant in both specifications at the one per cent level. Furthermore, the size of the drop is large: the slope of the Phillips curve almost halves. Thus, unlike Farès and Lemieux (2000), we find significant evidence of a fall in the slope of the basic Phillips curve in the low inflation era of the 1990s.

3. Hysteresis Model

Our next empirical model allows for the possibility of hysteresis in the Phillips curve, so that the level of wage inflation depends not only on the gap between the unemployment rate and the natural rate, but also the change in unemployment rate. Once again we allow for the possibility that the slope of the Phillips curve has shifted in the 1990s. The empirical specification adopted is the following:

$$\dot{W}_{it} = \dot{P}^{e}_{it} + \dot{G}_{it} - (b_1 + b_2 \cdot YRGT91) \cdot \left((1-h) \cdot \left(u_{it} - u^{n}_{it}\right) + h \cdot \Delta u_{it}\right) + b_3 \cdot YRGT91 + e_{it} \quad (9)$$

where as in the theoretical specification, h represents the degree of hysteresis, with h=1 being full hysteresis, when wage inflation no longer depends on the gap between the unemployment rate and the natural rate.

The results from estimating (9) are also shown in Table 2. The slope of the Phillips curve (b_1) is statistically significant at the one per cent level in both specifications of the hysteresis model. The EI disincentives variable is not significant and incorrectly signed in specification (2). This variable is removed in specification (3). Although economically significant and statistically significant at the one per cent level, the estimate of 0.37 for the hysteresis parameter suggests that the Phillips curve is not characterised by very high level of hysteresis. As with the basic specification, the coefficient for a change in the slope of the Phillips curve (b_2) is also statistically significant at the one per cent level, and economically large and negative, consistent with downward nominal wage rigidity. It is therefore not possible to argue, at least based on these results, that the apparent shift in the Phillips curve in the 1990s in the basic model is a result of not allowing for hysteresis.

4. Downward Nominal Wage Rigidity Model

The previous specifications allow for downward nominal wage rigidity by allowing the slope of the Phillips curve to change in periods after 1991. This is not a bad approximation—the slope of the short run Phillips curve does indeed become flatter in the downward nominal wage rigidity model when inflation is lower, *ceteris paribus*; however, the downward nominal wage rigidity short run Phillips curve is actually a non-linear function, and therefore changes in the slope and intercept of a linear Phillips curve can only be a local approximation. Also, using a dummy variable to essentially allow for a discrete regime shift after 1991 is again only an approximation: in reality the downward nominal wage rigidity becomes progressively more binding as expected inflation and expected productivity growth become lower and the gap between unemployment rate and the natural unemployment rate becomes higher.

Thus in order to get a more precise idea of downward nominal wage rigidity it is better to go to the non-linear downward nominal wage rigidity discussed in Section III. In order to test for whether the downward nominal wage rigidity constraint is binding, we follow

Fortin and Dumont (2000) by generalising the downward nominal wage rigidity constraint to allow for a bound on nominal wages different from zero, so that the downward nominal wage rigidity Phillips curve becomes

$$\dot{W} = f + \Psi_{\sigma}\left(\dot{P}^{e} + \dot{G}^{e} - b(u - u^{*}) - f\right). \tag{10}$$

f=0 corresponds to a constraint of zero on nominal wage changes. As $f \to -\infty$, the wage floor becomes increasing less binding.

The empirical results from the downward nominal wage rigidity model are shown in Table 3 below. In both cases the slope coefficient (b) is economically significant and statistically significant at the one per cent level, as is the EI disincentives variable and the relative minimum wage variable. Crucially for the downward nominal wage rigidity hypothesis, the f variable is not significantly different from zero at any standard significance level, indicating that the data accept the downward nominal wage rigidity hypothesis. It is also notable that the determinant of the residual covariance matrix is much lower than for previous specifications, indicating a better fit for this model, despite its having as many or fewer parameters.[11]

[11] The determinant of the residual covariance matrix is a measure of the size of the residuals (similar to the Akaike Information Criterion) and may be used as a measure of the goodness of fit.

Table 3: Results from the Downward Nominal Wage Rigidity Model

	(7)		(8)	
	estimate	*std err*	*estimate*	*std err*
b	0.81	(0.09)	0.79	(0.09)
sigma	4.85	(0.54)	5.74	(1.57)
f			-0.63	(1.03)
EI	0.04	(0.006)	0.04	(0.006)
MW	0.25	(0.06)	0.24	(0.06)
NF	-5.22	(3.35)	-4.77	(3.31)
PE	-11.09	(3.70)	-10.59	(3.67)
NS	-9.43	(3.27)	-9.12	(3.25)
NB	-9.86	(3.37)	-9.50	(3.34)
QC	-11.01	(3.38)	-10.71	(3.37)
ON	-11.12	(2.99)	-10.88	(2.99)
MB	-12.77	(3.26)	-12.52	(3.24)
SK	-15.19	(3.44)	-14.94	(3.43)
AB	-10.73	(2.88)	-10.52	(2.87)
BC	-10.28	(3.07)	-9.99	(3.07)
Det. Res. Cov.	1.43E-14		1.30E-14	

Notes: Sample period is 1981–1999. Dependent variable is log change in wages less expected inflation and expected productivity growth. The estimation method was SUR. See the Data Appendix for variable definitions. The estimates reported for EI, MW and the province dummy variables correspond to a_1, a_3 and c^1 in equation (12) respectively.

The advantage of incorporating downward nominal wage rigidity explicitly into the Phillips curve, rather than just allowing the slope to differ after 1991 is that it allows us to make predictions about the unemployment costs of further reductions in inflation. If we assume that productivity growth, EI disincentives and the relative minimum wage are at their 1999 levels, a simulation of specification (7) implies that a reduction in inflation by one percentage point will result in a long-run increase in unemployment of about one percentage point. However, because of the non-linear nature of the long-run Phillips curve under downward nominal wage rigidity, an increase of inflation of one percentage point would only allow a fall in unemployment of about 0.5 percentage points.[12]

It is important to bear in mind that these results do not necessarily provide a compelling argument for raising the rate of inflation. It is possible that the downward nominal wage

[12] As part of work focussing on the natural rate several versions of specification (7) were estimated. These results are derived from a version where inflation is moderately smoothed rather than the version reported in Table 3. Nevertheless, all versions exhibited this asymmetric response.

rigidity picked up by our model is not permanent and will disappear once workers' expectations adjust to the new regime. Furthermore, higher productivity growth would make the downward nominal wage rigidity constraint less binding; significant productivity growth in the future would lower the unemployment cost of lower inflation. Lastly, any consideration of changing the targets must also consider the benefits of low inflation, an issue not addressed in this analysis.

V. Conclusions

As noted at the beginning of this paper, it is possible that lowering the inflation rate would entail higher unemployment either because of hysteresis or because of downward nominal wage rigidity in the Phillips curve relationship. In this paper we have found only limited evidence of hysteresis; however we have found significant evidence of downward nominal wage rigidity in all three models studied.

Our results are quite different from those of Farès and Lemieux, despite their similar methodology. This may in part be due to the different wage data used, but we suspect that a more fundamental reason is that we model explicitly variations in provincial natural rates and productivity, rather than using time trends or year dummies, and that this allows us to obtain more precise estimates of the Phillips curve relationship. This difference is more than just a question of econometric methodology. It goes to the heart of explaining the events of the last twenty years, and the crucial question: why was the recovery from the 1991–1992 recession so slow, despite reforms to social programmes that should have lowered the natural rate of unemployment? Proponents of downward nominal wage rigidity have an answer to this question. In order to be convincing, those opposed to this thesis must provide another answer to this question. Simply 'explaining' higher unemployment by a constant upwards trend is not likely to be convincing unless one can point to some corresponding structural trend in the natural rate over this time. Candidates for such an upward trend are not easy to find, given the aforementioned reforms to social programmes and the lack of evidence that structural changes in the economy increased unemployment over this period.

Although our results do provide significant evidence in favour of the hypothesis that downward nominal wage rigidity is an important feature of the Canadian labour market, the reader should be very careful in drawing policy conclusions from our result that permanently lowering inflation by one percentage point would require an increase in unemployment of about one percentage point. It is possible to argue that because our sample only includes seven years of very low inflation, it may be that the downward nominal wage rigidity that our model picks up is not permanent, and that once workers' expectations adjust to the new regime downward nominal wage rigidity will disappear. More crucially, it is important to remember that just as lower inflation makes the downward nominal wage rigidity constraint more binding, higher productivity growth makes it less binding, because there is less need for nominal wage cuts. For this reason our results on the unemployment costs of moving to lower inflation in the future should be regarded as suggestive, rather than definitive.

Data Appendix

1. Earnings Growth

The measure of earnings used is average nominal weekly earnings including overtime for all workers (both salaried and paid hourly). The measure represents a industrial composite. These data are from the Survey of Payroll and Hours (SEPH) from 1983 on, and from the old Employment Survey before that date. The earlier data was linked to the data from the later period by multiplying the earlier data by the average over the three months of January 1983 to March 1983 of the ratio of the later measure to the earlier measure. Growth rates of this series are constructed as differences in natural logarithms.

2. Expected Rate of Inflation

Annual consumer price index series by province are constructed as the average of quarterly consumer price index series (1992=100) obtained from the Conference Board of Canada. Rates of inflation were constructed as differences in natural logarithms. The expected rate of inflation is defined as the actual rate of inflation lagged 1 period.

3. Expected Rates of Productivity Growth

A productivity index is constructed as the ratio of real gross domestic product to total employment. Gross domestic product is valued by factor cost in 1992 dollars and these series are from the Conference Board of Canada. Quarterly series are summed to arrive at annual series. Total employment includes both paid and self-employed workers and is from the Labour Force Historical Review. The productivity index represents thousands of $1992 per employed person.

Growth rates of this index are constructed as differences in natural logarithms and the expected rate of growth is the Hoderick-Prescott filtered growth rate, with a smoothing parameter set to the conventional level of 100.

4. Unemployment Rates

The analysis uses unemployment rates for individuals of both sexes aged 15+ years. Source: Labour Force Historical Review.

5. UI/EI Disincentives Index

This is an updated version of the index described in Sargent (1998).

6. Social Assistance Disincentives Index

An index of social assistance disincentives is constructed as the ratio of a measure of annual welfare benefit payments to the provincial CPI. Monthly social assistance benefits represent the maximum potential benefits (including basic allowance and allowances for shelter and utilities) for single individuals classified as being employable. Annual levels of benefits were computed assuming a person began receiving welfare benefits on January 1st of a given year and remained on welfare until December 31st of that year. During various periods between 1976 and 1999 period there existed in Quebec and B.C. differential benefit rates based on a threshold age level. Benefit rates for these periods are calculated as the average level of benefits where the proportions of such individuals in the two age groups are used as weights.

Welfare rates by type of recipient were obtained from volumes of the Provincial Gazettes (various years) and also directly from provincial ministries. For further details see Stark (2000).

7. Weekly Minimum Wage Earnings

Levels of real weekly minimum wage earnings are computed assuming a 40-hour work week using data from volumes of the Provincial Gazettes (various years). A relative minimum wage series is then constructed by dividing by average weekly earnings.

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